**General Insurance
Ratemaking & Reserving**

Exam GIRR

Date: Wednesday, November 8, 2023

INSTRUCTIONS TO CANDIDATES

General Instructions

1. This examination has 15 questions numbered 1 through 15 with a total of 70 points.

   The points for each question are indicated at the beginning of the question.

2. While every attempt is made to avoid defective questions, sometimes they do occur. If you believe a question is defective, the supervisor or proctor cannot give you any guidance beyond the instructions provided in this document.

Written-Answer Instructions

1. Each question part or subpart should be answered either in the Word document or the Excel file as directed. Graders will only look at work in the indicated file.

   a) In the Word document, answers should be entered in the box marked ANSWER. The box will expand as lines of text are added. There is no need to use special characters or subscripts (though they may be used). For example, β_1 can be typed as beta_1 and σ^2 can be typed as sigma^2.

   b) Calculations should be done in Excel and entered as formulas. Performing calculations on scratch paper or with a calculator and then entering the answer in the cell will not earn full credit. Formatting of cells or rounding is not required for credit. Rows can be inserted to the answer input area as required to provide space for your answer.

   c) Individual exams may provide additional directions that apply throughout the exam or to individual items.

2. The answer should be confined to the question as set.

3. Prior to uploading your Word and Excel files, each file should be saved and renamed with your five-digit candidate number in the filename.

4. The Word and Excel files that contain your answers must be uploaded before the five-minute upload period expires.

Navigation Instructions

Open the Navigation Pane to jump to questions.

Press Ctrl+F, or click View > Navigation Pane:
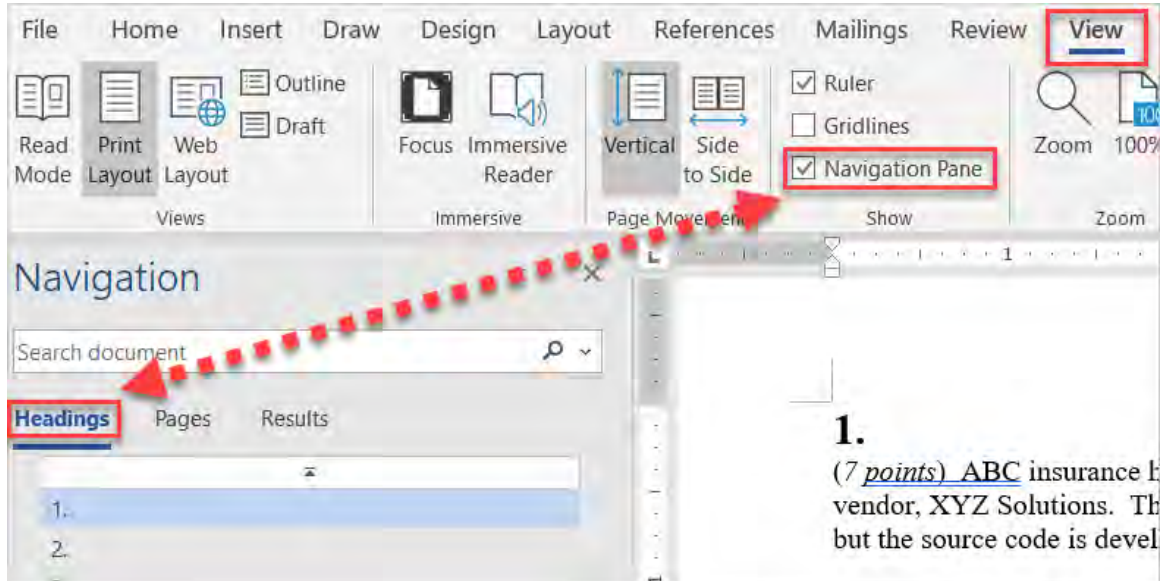
1.

(*6 points*) An insurer began writing policies in 2019. You are given the following:

Accident	Reported Claims (000)			
Year	12	24	36	48
2019	1,148	1,783	2,526	3,410
2020	3,427	4,893	6,847	
2021	5,710	12,170		
2022	8,035			

Accident	Paid Claims (000)			
Year	12	24	36	48
2019	138	466	882	1,425
2020	413	1,269	3,148	
2021	689	4,140		
2022	1,286			

It was subsequently discovered that the following claims and their transactions were not captured in the triangles.

Claim ID	Occurrence Date
100	Oct. 11, 2019
200	Jan. 5, 2020
300	Feb. 28, 2021

Trans #	Claim ID	Transaction Date	Transaction Description	Change in Case Estimate (000)	Payment (000)
1	200	Feb. 7, 2020	Open new claim file	17	
2	100	May 12, 2020	Open new claim file	5	
3	300	Mar. 8, 2021	Open new claim file	29	
4	100	Jul. 22, 2021	Payment & change in case estimate	–5	6
5	200	Nov. 13, 2021	Payment & change in case estimate	–13	6
6	300	Jun. 4, 2022	Payment		11

(a) (*3 points*) Update both triangles to include the missing transactions.

(b) (*1 point*) Identify an anomaly in the triangle of ratios of paid claims to reported claims based on the corrected triangles from part (a).

1. Continued

(c)   (*1 point*) Describe two operational changes that could have caused the anomaly you identified in part (b).

You are given the following carried IBNR reserves:

IBNR Reserves (000)	
Dec 31, 2019	4,591
Dec 31, 2020	17,722
Dec 31, 2021	38,476
Dec 31, 2022	61,299

(d)   (*1 point*) Calculate incurred claims for calendar year 2021.

2.

(*5 points*) You are given the following estimates of ultimate claims as of December 31, 2022 using various projection methods for paid and reported datasets for ABC Insurance:

Accident Year (AY)	Paid Claims	Estimated Ultimate Claims Derived from Paid Claims			
		Development Method	Frequency-Severity Method	Expected Method	Bornhuetter Ferguson Method
2016	4,061,301	4,213,797	3,713,314	3,621,490	4,192,361
2017	3,886,797	4,184,164	3,962,745	*3,785,648*	4,155,841
2018	3,473,991	4,362,003	4,194,937	4,031,681	4,294,757
2019	2,634,801	4,567,645	4,428,939	4,369,286	4,483,708
2020	1,668,537	4,583,998	4,706,684	4,614,726	*4,603,541*
2021	841,930	4,747,208	5,046,721	4,938,526	4,904,595
2022	234,974	4,861,561	5,600,346	5,553,008	5,519,588
Total	**16,802,331**	**31,520,376**	**31,653,686**	**30,914,365**	**32,154,391**

Accident Year (AY)	Reported Claims	Estimated Ultimate Claims Derived from Reported Claims			
		Development Method	Frequency-Severity Method	Expected Method	Bornhuetter Ferguson Method
2016	4,286,393	4,408,940	4,521,400	4,507,837	4,411,689
2017	4,481,291	4,741,193	4,824,445	4,712,173	4,739,602
2018	4,206,123	5,012,214	5,107,961	5,018,421	5,013,213
2019	3,595,110	5,437,466	5,396,261	5,438,653	5,437,869
2020	2,701,167	5,733,690	5,731,620	5,744,164	5,739,229
2021	1,772,745	6,159,764	6,145,839	6,147,213	6,150,825
2022	944,060	*6,654,576*	6,820,458	6,912,087	6,875,555
Total	**21,986,889**	**38,147,843**	**38,547,984**	**38,480,548**	**38,367,982**

- The data used in estimating ultimate claims has not been adjusted for any changing conditions in the book of business.
- Investigative testing indicates that the change in average case outstanding has increased and the change is consistent with claim trend over the historical period.
- Investigative testing also indicates that the claim settlement rate has decreased significantly in the most recent calendar year.

2. **Continued**

(a) (*3 points*) Evaluate the reasonableness of each of the following methods and datasets for estimating ABC Insurance's ultimate claims:

(i) Expected method based on paid claims for AY 2017

(ii) Bornhuetter Ferguson method based on paid claims for AY 2020

(iii) Reported development method for AY 2022

ANSWER:

(i)

(ii)

(iii)

(b) (*1 point*) Recommend ultimate claims from a method and dataset for AY 2021. Justify your recommendation.

ANSWER:

You have adjusted the data to account for any changing conditions and recalculated the ultimate claims estimates.

(c) (*1 point*) Evaluate the reasonableness of the AY 2021 ultimate claims estimate using the paid development method after adjustment.

ANSWER:

3.

(*4 points*) You are determining a loading for large claims on a homeowners book of business for a ratemaking exercise.

(a) (*0.5 points*) State two reasons for using a large claim loading approach when estimating ultimate claims at total limits for ratemaking.

You are given the following:

Accident Year	Selected Ultimate Claims at 500,000 Limit	Selected Ultimate Claims at Total Limits
2019	9,850,000	12,108,000
2020	10,365,000	12,658,000
2021	11,275,000	15,334,000
2022	12,385,000	14,357,000

- New rates are effective October 1, 2023 for one year.
- All policies are written for 6-month policy terms.
- The annual severity trend at 500,000 limit is 5%.
- The annual severity trend at total limits is 7%.
- The indicated large claims loading for 500,000 to total limits is 1.28 for the prospective rating period.
- The experience for this homeowners book of business is considered fully credible.

(b) (*2 points*) Calculate the large claim loadings at 500,000 limit, adjusted to the cost level for each accident year.

(c) (*0.5 points*) Calculate ultimate claims at total limits for each accident year using selected ultimate claims at a 500,000 limit and the large claim loadings from part (b).

(d) (*1 point*) Describe how the calculations in part (b) are affected when the experience is less than fully credible.

4.

(*5 points*) You are estimating unpaid ULAE as of December 31, 2022 using the Wendy Johnson count-based method. You are given the following. Forecasted incremental reported counts are highlighted with a shaded background.

Accident Year (AY)	Incremental Reported Counts							Ultimate Counts
	12	24	36	48	60	72	84	
2017	401	111	78	69	47	26	*42*	774
2018	410	103	95	68	39	*45*	*23*	783
2019	410	114	94	67	*47*	*47*	*24*	803
2020	410	120	95	*67*	*50*	*51*	*25*	818
2021	425	111	**95**	*66*	*49*	*49*	*25*	820
2022	434	*120*	*96*	*66*	*50*	*50*	*25*	841

Selected Ratios of Reported Counts to Ultimate Counts						
12	24	36	48	60	72	84
0.510	0.654	0.770	0.850	0.910	0.970	1.000

(a)   (*1 point*) Verify that the forecasted incremental reported count for AY 2021 at 36 months is 95.

You are given the following additional information:

Accident Year	Incremental Closed Counts						
	12	24	36	48	60	72	84
2017	138	166	132	122	99	73	*44*
2018	141	160	154	119	92	*73*	*44*
2019	141	171	148	123	*99*	*75*	*46*
2020	141	177	149	*127*	*101*	*77*	*46*
2021	146	170	*154*	*126*	*101*	*77*	*46*
2022	149	*177*	*158*	*129*	*102*	*79*	*47*

Calendar Year	Paid ULAE	Newly Reported Counts	Open Counts	Closed Counts
2020	640,000	796	786	792
2021	675,000	819	802	803
2022	692,000	814	816	800

4. Continued

Use the following weights for the three types of claim counts:

Newly reported counts	25%
Open counts	65%
Closed counts	10%

- The past annual expense trend rate through 2023 is 2%.
- The future annual expense trend rate after 2023 is 3%.

(b)   (*4 points*) Estimate unpaid ULAE as of December 31, 2022 using a simple three-year average of historical experience.

5.

(*4 points*) You are estimating IBNR as of December 31, 2022, using the Cape Cod method. You are given the following:

Accident Year	On-Level Earned Premiums	Reported Claims	Reported Cumulative Development Factors
2019	15,700	8,200	1.10
2020	15,200	6,200	1.50
2021	15,800	3,500	2.20
2022	16,300	1,500	4.00

- The annual claim trend is 3%.
- A recent court decision has resulted in an estimated claim increase of 10% for all accidents on occurring or after January 1, 2021.

(a)   (*3.5 points*) Calculate the IBNR for all accident years using the Cape Cod method.

(b)   (*0.5 points*) Calculate the accident year 2021 IBNR using the Generalized Cape Cod method and a decay factor of 0%.

6.

(*3 points*) You are conducting an exposure and premium trend analysis for ratemaking purposes.

(a)   (*0.5 points*) Describe why you would adjust actual historical premiums to current rate levels before analyzing premium trend.

> ANSWER:

(b)   (*0.5 points*) Describe an advantage of using written premiums instead of earned premiums for a premium trend analysis.

> ANSWER:

(c)   (*0.5 points*) Describe why an adjustment for inflation is required if premiums are based on inflation-sensitive exposures.

> ANSWER:

(d)   (*0.5 points*) Describe why an increasing proportion of insureds replacing their old vehicles with new vehicles might affect premium trend factors.

> ANSWER:

(e)   (*1 point*) Describe how a premium trend analysis for an insurer's book of business is different from a premium trend analysis for a self-insurer.

> ANSWER:

7.

(*4 points*) You are estimating unpaid claims for lines of business where conditions have been changing.

(a)   (*1 point*) Explain whether the Bornhuetter Ferguson method or Cape Cod method is more responsive to a deterioration in claims experience.

> ANSWER:

A recent court decision has resulted in increased claim payments on private passenger automobile policies effective July 1, 2020.

(b)   (*1 point*) Describe how this change affects the reported claims development triangle evaluated as of December 31, 2022, assuming the following:

  (i)   The court decision affects only new claims.

  (ii)   The court decision affects new and open claims.

> ANSWER:
>
> (i)
>
> (ii)

(c)   (*1 point*) Describe why the Cape Cod method could be appropriate when estimating claims under scenario (b)(i) above.

> ANSWER:

(d)   (*1 point*) Describe why a Berquist-Sherman data adjustment could be appropriate when estimating claims under scenario (b)(ii) above.

> ANSWER:

8.

(*4 points*) The two most common models for determining trend rates are linear and exponential.

(a) (*0.5 points*) Explain why a linear trend model may not be appropriate when trend is decreasing.

You are given the following:

Accident Year	Earned Exposures	Ultimate Counts	Indicated Claim Frequency
2016	15,859	1,454	9.17%
2017	16,140	1,452	9.00%
2018	16,265	1,457	8.96%
2019	16,319	1,453	8.90%
2020	16,536	1,442	8.72%
2021	16,928	1,464	8.65%
2022	16,842	1,475	8.76%

Indicated annual trend, using an exponential model	
All years	–0.86%
AY2017-AY2022	–0.74%
AY2016-AY2021	–1.11%

(b) (*0.5 points*) Recommend an annual claim frequency trend to use for this line of business. Justify your recommendation.

8. **Continued**

You are also given the following:

Accident Year	Ultimate Severity
2016	3,750
2017	3,993
2018	4,230
2019	4,489
2020	4,679
2021	5,048
2022	5,409

- The annual severity trend is 6.0%.
- Ultimate counts and ultimate severity were determined based on the development method.

(c) (*3 points*) Calculate projected ultimate claims using the development-based frequency-severity method and your recommended annual claim frequency trend.

9.

(*5 points*) You are conducting a ratemaking analysis and are given the following historical rate change information:

Effective Date of Rate Change	Rate Change
July 1, 2019	3%
July 1, 2020	7%
April 1, 2022	6%

- Premiums are written evenly throughout the year.
- Premiums are earned evenly throughout the policy term.
- Prior to January 1, 2020, all policies were written for 12-month terms.
- Since January 1, 2020, 50% of policies have been written for 12-month terms and 50% of policies have been written for 6-month terms.
- There have been no rate changes since April 1, 2022.

(a) (*0.5 points*) Provide one reason why the company would want to write more 6-month policies in this situation.

(b) (*3 points*) Calculate the premium on-level factors for calendar years 2019 through 2022 to use in estimating expected claim ratios for the ratemaking analysis.

You also need to determine premium on-level factors to use in estimating expected claim ratios for reserves as of December 31, 2022.

(c) (*1 point*) Explain why the on-level factors needed for reserving would be lower than the on-level factors calculated in part (b).

Premiums also need to be adjusted to ultimate values in certain situations.

(d) (*0.5 points*) Provide one situation where actuaries would need to determine an estimate of ultimate premiums.

10.

(*5 points*) You are estimating ultimate claims.

(a)   (*0.5 points*) Describe two situations where the expected method is most often used when estimating ultimate claims.

(b)   (*0.5 points*) Describe the primary assumption of the expected method.

You are given the following as of December 31, 2022.

Accident Year (AY)	Reported Claims (000)					Projected Ultimate Claims (000) Based on Development Method
	12	**24**	**36**	**48**	**60**	
2018	6,750	8,295	9,780	10,670	10,990	11,753
2019	7,375	9,268	10,843	11,808		13,006
2020	8,000	10,240	12,083			14,507
2021	8,625	11,213				15,836
2022	9,250					16,544

Calendar Year	Earned Premiums (000)	Earned Exposures (000)	Premium On Level Factors
2018	14,750	195	1.103
2019	15,895	205	1.098
2020	17,400	225	1.060
2021	18,705	235	1.034
2022	20,010	236	1.000

The annual trend rate for claim ratios and pure premiums is 3%.

(c)   (*1.5 points*) Calculate the expected claim ratios for each year at the 2022 cost level using reported claims.

(d)   (*0.5 points*) Calculate the pure premiums for each year at the 2022 cost level using reported claims.

10. **Continued**

    (e)   (*2 points*) Calculate the accident year 2021 ultimate claims using the Bornhuetter Ferguson method and:

        (i)   A selected expected claim ratio of 82% at the 2022 cost level

        (ii)   A selected pure premium of 69 at the 2022 cost level

11.

(*5 points*) You are analyzing expenses for ratemaking. The trend in fixed expenses is often analyzed separately from the trend in average premiums.

(a)   (*0.5 points*) Identify why a separate trending procedure for fixed expenses may not be required when analyzed on a per-exposure basis.

You are given the following:

Calendar Year	Fixed Expenses	Earned Premiums	Earned Premiums at Current Rates
2016	461,512	5,177,046	6,750,220
2017	493,686	5,615,887	7,026,059
2018	530,358	6,172,433	7,435,117
2019	571,399	6,749,414	7,835,156
2020	622,827	7,607,009	8,295,015
2021	665,497	8,102,719	8,667,071
2022	725,652	8,760,790	9,164,015

- New rates are effective November 1, 2023 for one year.
- All policies are written for 12-month policy terms.
- Premiums are written evenly throughout the year.
- Premiums are earned and fixed expenses are incurred evenly throughout the policy term.

(b)   (*2 points*) Recommend an annual fixed expense trend. Justify your recommendation.

(c)   (*2.5 points*) Recommend a fixed expense ratio to be used in ratemaking. Justify your recommendation.

12.

(*6 points*) You are conducting a ratemaking analysis and are given the following:

Accident Year	Earned Exposures	Earned Premiums at Current Rate Level	Ultimate Counts	Ultimate Claims
2018	10,146	9,400,897	862	13,085,953
2019	10,127	9,537,898	869	14,011,147
2020	10,298	9,901,002	875	14,968,858
2021	10,291	10,263,291	852	15,499,745
2022	10,573	10,713,349	883	18,068,228

- The historical annual claim frequency trend was –1.0%.
- The annual claim frequency trend is expected to increase to 1.0% for all accidents occurring after December 31, 2022.
- The historical annual claim severity trend was 6.0% and is not expected to change in the future.
- The new rates are effective March 1, 2024 for one year.
- All policies are written for 12-month policy terms.
- The full credibility standard is 4,654 ultimate counts.
- The square root rule is used for partial credibility.

(a)   (*2 points*) Calculate the trended pure premiums for each accident year.

(b)   (*1 point*) Recommend a trended pure premium. Justify your recommendation.

You are also given the following:

- The complement of credibility is derived using the average pure premium underlying the current rates adjusted to the cost level of the forecast period of the new rates.
- The current rates are based on the prior ratemaking analysis that was applied to policies effective July 1, 2022 through June 30, 2023, with average pure premium of 1,700.

(c)   (*1 point*) Calculate the pure premium to use for the complement of credibility.

12. Continued

You are also given the following:

- Fixed expenses per exposure are 125.
- The ratio of ULAE to claims is 4%.
- The ratio of variable expenses to premiums is 18%.
- The ratio of profit and contingencies to premiums is 5%.

(d)   (*1.5 points*) Calculate the credibility-weighted indicated rate.

An alternative for the complement of credibility is to use a pure premium based on industry experience.

(e)   (*0.5 points*) Identify one adjustment that is necessary when relying on a complement of credibility that is a pure premium based on industry experience.

13.

(*4 points*) You are given the following:

Accident	Reported Claims (000)						
Year	12	24	36	48	60	72	84
2016	1,826	2,742	2,948	3,174	3,239	3,248	3,248
2017	2,296	3,656	3,928	4,230	4,458	4,506	
2018	3,064	4,932	5,465	6,104	6,373		
2019	2,327	3,675	4,522	5,124			
2020	2,691	4,495	4,924				
2021	2,497	5,025					
2022	3,740						

Accident	Age-to-Age Factors					
Year	12-24	24-36	36-48	48-60	60-72	72-84
Volume-weighted average (all years)	1.668	1.117	1.105	1.042	1.007	1.000

- There is no development beyond 84 months.
- The reported claims history includes two large claims.
- Large claim #1 occurred on July 1, 2019 and was reported on January 20, 2021. The initial case estimate was 500,000.
- Large claim #2 occurred on September 10, 2021 and was reported on March 2, 2022. The initial case estimate was 1.0 million.
- These large claims have not had any payments made or adjustments to case estimates as of December 31, 2022.

Your colleague recommends using the volume-weighted average of all years for age-to-age development factors.

(a)   (*0.5 points*) Identify a potential problem with your colleague's recommendation.

(b)   (*0.5 points*) Describe an alternative approach to your colleague's recommendation.

(c)   (*2.5 points*) Estimate total ultimate claims based on the development method and your alternative from part (b).

13. **Continued**

(d)   (*0.5 points*) Describe how you would adjust for the large claims when estimating ultimate claims based on the paid development method for this line of business.

14.

(*5 points*) You are analyzing a triangle of average reported claims. There are several actions that could result in shifts in reported claim patterns. One example is a new approach to setting case estimate amounts.

(a)   (*1 point*) Identify two other examples of actions that could result in shifts in a reported claim pattern.

You are given the following:

Accident	Reported Claims					
Year	12	24	36	48	60	72
2017	3,258,495	4,632,313	5,665,417	6,660,535	7,372,368	7,702,277
2018	3,556,049	4,925,302	6,252,176	7,431,788	8,060,259	
2019	3,798,926	5,378,090	6,921,131	8,051,684		
2020	4,174,496	6,013,059	7,664,425			
2021	4,854,244	6,611,842				
2022	5,320,155					

Accident	Paid Claims					
Year	12	24	36	48	60	72
2017	1,227,967	2,870,190	4,218,215	5,649,515	6,801,540	7,532,219
2018	1,254,169	2,975,612	4,720,518	6,197,891	7,435,993	
2019	1,406,648	3,267,932	5,029,042	6,714,834		
2020	1,575,637	3,453,821	5,616,379			
2021	1,667,172	3,913,397				
2022	1,754,839					

Accident	Reported Counts					
Year	12	24	36	48	60	72
2017	705	864	996	1,080	1,147	1,185
2018	733	883	1,018	1,112	1,181	
2019	734	900	1,028	1,148		
2020	756	928	1,077			
2021	773	947				
2022	789					

14. Continued

Accident	Closed Counts					
Year	12	24	36	48	60	72
2017	310	571	780	938	1,077	1,179
2018	327	581	797	967	1,109	
2019	323	587	802	1,000		
2020	334	605	845			
2021	353	622				
2022	352					

- The annual claim severity trend is 6.3%.

Your colleague has assumed that case reserve adequacy was strengthened in calendar year 2021.

(b)   (*1.5 points*) Verify your colleague's assumption.

Your colleague recommends using the calendar year 2021 diagonal to adjust for a change in case reserve adequacy.

(c)   (*0.5 points*) Critique your colleague's recommendation.

(d)   (*2 points*) Construct a reported claims triangle adjusted for the change in case adequacy, basing the adjustments on the calendar year 2022 diagonal.

15.

(*5 points*) You are given the following:

Policy Number	Policy Premium	Policy Effective Date	Policy Expiration Date
501	5,000	July 1, 2020	June 30, 2022
502	3,600	April 1, 2021	March 31, 2024
503	2,400	January 1, 2022	December 31, 2024
504	4,800	September 1, 2022	August 31, 2024

- The written premiums are divided into equal annual values and recorded on each anniversary of the effective date.
- Premiums are earned evenly throughout the policy term.
- There were no cancellations.

(a) (*1 point*) Calculate the written premiums for 2022.

(b) (*1 point*) Calculate the earned premiums for 2022.

(c) (*1 point*) Calculate the unearned premiums as of December 31, 2022.

It was subsequently noticed that policy 504 was a motorcycle policy that was priced assuming it was not operated from October 1 through March 31 each year.

(d) (*1 point*) Recalculate the 2022 earned premium for policy 504.

(e) (*0.5 points*) Recalculate the unearned premium as of December 31, 2022 for policy 504.

(f) (*0.5 points*) Describe why the parallelogram approximation would not be appropriate when adjusting historical premiums to current rate levels for policies such as policy 504.

END OF EXAMINATION